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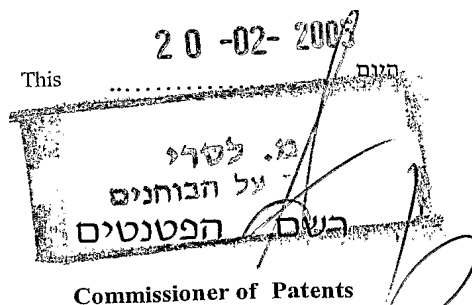
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Application For Patent

אני, (שם המבקש, מענו ולגבי גוף מאוגד - מקום ההתאגדות)
I (Name and address of applicant, and in case of body corporate-place of incorporation)

KORNIT DIGITAL LTD.

P.O.Box 3194

20 Hameretz St.

Kiryat Arie

Petah Tikva 49517

Israel

קורנית דיגיטל בע"מ

רח' המרץ 20

ת.ד. 3194

קרית אריה,

פתח תקווה 49517 ישראל

ששמה הוא

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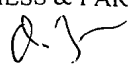
(באנגלית)

A Direct Digital Printing Process Of An Inkjet Ink Onto A Wet Textile Piece

(English)

hereby apply for a patent to be granted to me in respect thereof.

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Dr. Yitzhak Hess & Partners P.O.B. 6451 TEL AVIV 61063				ד"ר יצחק הס ושותפיו ת.ד. 6451 תל אביב 61063		
Signature of Applicant For the applicant: DR. YITZHAK HESS & PARTNERS BY : 				היום 27 בחודש מאי שנת 2004 This of the year of		
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תהליך הדפסה דיגיטלי ישיר של הזרקת דיו בהנעה סילונית על קטע אריג רטוב

A Direct Digital Printing Process Of An Inkjet Ink Onto A Wet Textile Piece

KORNIT DIGITAL LTD.

The present invention relates to a direct digital printing process of an inkjet ink onto a wet textile piece.

Screen- printing is the leading technology for garment and textile pieces printing. The inks used in this application may be either solvent- based plastisols or water based inks.

Such ink types are medium to heavy pastes that will not flow after application on the textile piece. Said pastes are cured/dried after exposure to heat sources, mainly IR and hot air.

Solvent- based plastisols usually form a thick film layer on the surface which layer has most of the times a very unpleasant touch. In addition to that, the printed area is mainly sealed due to film formation, therefore the fabric stops breathing.

Water based screen-printing inks have a soft hand and are breathable but require longer cure schedules and higher temperatures than the plastisols.

The main disadvantage of screen-printing technology is the poor process printing ability. It is very difficult and sometimes impossible to print a full process image such as photo-realistic pictures using screen- printing technology. In addition, multi color images containing more than 8 different colors are considered as complicated due to registration problems of the screens obtained.

In order to print such images garment printers use special transfer technologies in which the desired image is digitally printed onto a special paper which paper contains a special adhesion layer that after exposure to heat and pressure transfers the image onto the textile piece. The resulting image has nice colors and details but the printed area has a very unpleasant feel, and in many cases it cracks after laundry.

Another method consists in sublimation- printing, which is the most expensive technology for this purpose. In this case the ink is transferred by heat sublimation on the surface of the textile piece resulting in high quality images and a very soft hand textile piece. This method is only suitable for polyester blends fabrics.

Direct digital inkjet printing onto untreated textile pieces is problematic due to bleeding and absorption of the low viscosity inks that result in images having poor faded colors that are blurry and are unfocused or sharp.

In connection with the present invention the term "textile piece" comprises a textile piece proper, a garment, a textile fabric, etc.

There is no adequate industrial direct digital printing process known which is suitable for an industrial printing on untreated textile pieces (as herein defined) that will apply to a variety of untreated textile pieces and result in high quality, soft hand, durable prints.

At the present time there are known direct inkjet printing processes which require special pretreatments in order to achieve high quality and durable images. However, said pretreatments are time consuming and thus not applicable for the present purposes.

In order to achieve a direct inkjet printing process on textile pieces, there is a need for a fast, one step direct digital printing process that results in high quality durable images on most textile pieces. Moreover, there should be available materials which are suitable for the use in said process.

The present invention thus consists in a printing process of a solvent – or of a water-based digital ink directly onto a wet textile piece (as herein defined) that was previously wetted with a wetting composition comprising a high to low volatility solvent or a mixture of such solvents.

The wetting composition may contain also adhesion promoters.

The solvents of the wetting composition may have a surface tension lower than 50 dyn/cm, preferably 15-35 dyn/cm, and more preferably 18-25 dyn/cm

The solvents of the wetting composition used in connection with the solvent based inkjet ink are preferably selected among:

- Low alcohols such as ethanol, isopropanol and butanol;
- Aliphatic and aromatic hydrocarbons such as petroleum spirits;
- Glycol ethers such as methoxy propanol (PM);
- Glycol ether acetates such as butyl glycol acetate (EGBEA);
- Ketones such as cyclohexanone;
- and mixtures thereof.

The adhesion promoters used in the wetting composition in connection with the solvent based inkjet ink, if any, are present in concentrations up to 50% w/w and are suitably selected among:

- Acrylic polymers and copolymers emulsions/dispersions;

- Acrylic polymers and copolymers resins;
- Polyurethane polymers and copolymers emulsions/dispersions;
- Polyurethane polymers and copolymers resins;
- Aldehyde based resins with polyols (polyether, polyester, urethane and acrylate polyols) and a suitable catalyst;
- Copolymers of vinyl chloride and vinyl acetate with or without functional hydroxyl and/or carboxyl groups;
- Polyvinyl butyrals;
- Aminosilicones;
- and mixtures thereof.

When the inkjet inks are water based the wetting composition comprises preferably solvents selected among:

- Aliphatic and aromatic hydrocarbons such as petroleum spirit (80-100° C);
- Glycol ether acetates such as (EGBEA);
- Ketones such as cyclohexanone;
- low alcohols such as butanol;
- glycol ethers such as PM.

and optionally this wetting composition and mixtures thereof comprise also adhesion promoters selected among:

- Acrylic polymers and copolymers emulsions;
- Acrylic polymers and copolymers resins;
- Polyurethane polymers and copolymers emulsions;
- Polyurethane polymers and copolymers resins;
- Aldehyde based resins with polyols (polyether, polyester, urethane and acrylate polyols) and a suitable catalyst;
- Copolymers of vinyl chloride and vinyl acetate with or without functional hydroxyl and/or carboxyl groups;
- Polyvinyl butyrals;
- Aminosilicones;
- and mixtures thereof.

The wetting composition according to the present invention may comprise also

- Thickeners and rheology modifiers such as clays, polyacrylic acids, polysaccharides;
- Glycols such as propylene glycol and glycerin;
- Surface-active agents such as modified siloxanes; and
- Softeners such as phtalates.

The wetting composition to be used in the process according to the present invention are advantageously in amounts ranging from 0.05 cc per 1cm² to 5 cc per cm², preferably 0.1-1.0 cc per cm².

The above compositions may comprise other additional suitable compounds such as surface active agents, brighteners, etc.

The textile piece may be selected, for example, from:

- 100% cotton
- 100% Viscose
- 100% polyester
- 100% Nylon
- Blends of the above with or without Lycra/spandex.

The best results for using solvent based inkjet ink were obtained by using low alcohols:

1. Low to no bleeding.
2. High optical density and vivid colors.
3. Extended gamut.
4. A drop shape was noticed on top of the fabric.
5. No trace of alcohol was noticed after curing.

In order to improve image properties and minimize possible curling problems of fibers after washing, an addition of an acrylic emulsion to the alcohol was tested. A solution of 5% acrylic emulsion (around 50% solids) in ethanol was sprayed on a 100% cotton garment and immediately printed. The resulting image was better than the one obtained using only ethanol or other alcohols.

Another layer of such a solution was sprayed on top of the printed image. The result was quite surprising: The image did not loose its resolution and the colors were even stronger and brighter.

Similar tests were performed using water- based inkjet inks. The best results were obtained when using as solvents ethylene glycol butyl ether acetate (EGBEA), petroleum spirit (80-100) and cyclohexanone as part of the wetting compositions

The process is advantageously performed as follows:

The textile piece is being wetted on the fly with a wetting composition that may or may not contain adhesion promoters. Immediately after applying the composition the image is being printed while the textile piece is still wet. The printed textile is then cured regularly for 180 seconds at 150-170° C.

There are two options for a wetting composition to be applied prior and adjacent to the inkjet ink application:

1. There is applied to the textile piece a liquid or a mixture of liquids having surface tension lower than 50 dyn/cm, preferably 17-35 dyn/cm, and more preferably 18-25 dyn/cm or an aqueous based solvent, that evaporate during the curing process and leave no trace on the textile surface or body.

2. There is applied a composition of 1 to which are added adhesion promoters and other ingredients which improve final properties of the cured image.

The application method of liquid wetting compositions is not limited to spraying methods. The wetting composition may be applied by dipping, stamping, laminar flow applicators, brushing, etc.

The present invention will now be illustrated with reference to the following examples without being limited by same.

All examples were performed with a Kornit printing machine; Kornit 930.

Examples:

Example 1

0.40 g/cc² of butanol were sprayed uniformly on a 100% cotton garments using a spraying nozzle. Immediately after spraying, while the garment was still wet an image was printed on the wet fabric using an inkjet printing head and a solvent based digital ink. The inkjet composition was as follows:

- Ethylene glycol butyl ether acetate (EGBEA) 80.0 g
- Cyclohexanone 4.0 g
- Dipropylene glycol methyl ether (DPM) 10.0 g

- Microlith Black preparation 6.0 g

The ink was cured for 180 seconds in an infrared curing conveyor. The resulting image had no bleeding signs, the optical density was higher and less ink was transferred to the backside of the shirt comparing to a same image that was printed with no wetting process.

Example 2

0.40 g/cc² of a wetting solution comprising 97% isopropanol and 3% SCX 8383 acrylic emulsion (Johnson Polymers) were sprayed uniformly on a 100% cotton garments using a spraying nozzle. Immediately after spraying, while the garment was still wet an image was printed on the wet fabric. The ink composition was described in example 1.

The ink was cured for 60 seconds in an infrared curing conveyor. The resulting image had no bleeding signs, the optical density was higher and less ink was transferred to the backside of the garment comparing to a same image that was printed with no wetting process.

Example 3

0.40 g/cc² of a wetting solution comprising 100% petroleum ether (80-100) were applied uniformly on a 100% cotton garments using a pipette. Immediately after spraying, while the garment was still wet an image was printed on the wet fabric. The ink composition was described in example 1.

The ink was cured for 150 seconds at 150-170° C in an infrared curing conveyor. The resulting image had no bleeding signs, the optical density was higher and less ink was transferred to the backside of the garment comparing to a same image that was printed with no wetting process.

Example 4

0.60 g/cc² of a wetting solution comprising 100% EGBEA were applied uniformly on a 100% cotton garment. Immediately after spraying, while the garment was

still wet an image was printed on the wet fabric with a water based inkjet ink.

The printed inkjet composition was water based and had the following composition:

Cymel 323 (Cytec Industries) 30.0 g
PEG 35000 (Sigma – Aldrich) 4.0 g
Nacure 2501 (King Industries) 2.0 g
Dipropylene glycole methyl ether (Dow Chemicals) 15.0 g
Isopropanol 5.0 g
Distilled water 40.0 g
Spectra fix red 195 (Spectra Colors Group) 4.0 g

The ink was cured for 180 seconds at 150-180° C in an infrared curing conveyor. The resulting image had no bleeding signs, the optical density was higher and less ink was transferred to the backside of the garment comparing to a same image that was printed with no wetting process.

The resulting image had higher color intensities, no bleeding and the ink absorbed by the fabric was much lower than that without wetting the 100% cotton garment.

Example 5

0.60 g/cc² of a wetting solution comprising 100% cyclohexanone were applied uniformly on a 100% cotton garment. Immediately after spraying, while the garment was still wet an image was printed on the wet fabric.

The printed inkjet composition was water based and had the following composition:

Cymel 323 (Cytec Industries) 30.0 g
PEG 35000 (Sigma – Aldrich) 4.0 g
Nacure 2501 (King Industries) 2.0 g
Dipropylene glycole methyl ether (Dow Chemicals) 15.0 g
Isopropanol 5.0 g
Distilled water 40.0 g

Spectra fix red 195 (Spectra Colors Group) 4.0 g

The ink was cured for 180 seconds at 150-180° C in an infrared curing conveyor. The resulting image had little to no bleeding signs, the optical density was higher and less ink was transferred to the backside of the garment comparing to a same image that was printed with no wetting process.

The resulting image had higher color intensities, no bleeding and the ink absorbed by the fabric was much lower than without wetting the 100% cotton garment.

Example 6

0.40 g/cc² of ethanol were sprayed uniformly on a 100% cotton garments using a spraying nozzle. Immediately after spraying, while the garment was still wet an image was printed on the wet fabric. The inkjet ink was the same as indicated in Example 1.

The ink was cured for 180 seconds in an infrared curing conveyor. The resulting image had no bleeding signs, the optical density was higher and less ink was transferred to the backside of the shirt comparing to a same image that was printed with no wetting process.

Claims:

1. A printing process of a solvent – or of a water-based digital ink directly onto a wet textile piece (as herein defined) that was previously wetted with a wetting composition comprising a high to low volatility solvent or a mixture of such solvents.
2. A printing process according to Claim 1, wherein the wetting composition contains also an adhesion promoter.
3. A printing process according to Claim 1 or 2, wherein the wetting composition comprises a solvent which has a surface tension lower than 50 dyn/cm.
4. A printing process according to Claim 3, wherein the surface tension is 17-35 dyn/cm
5. A printing process according to Claim 4, wherein the surface tension is 18-25 dyn/cm.
6. A printing process according to any of Claims 1 to 5, wherein the inkjet ink is solvent based and the solvent in the wetting composition is selected among:
 - Low alcohols such as ethanol, isopropanol and butanol;
 - Aliphatic and aromatic hydrocarbons such as petroleum spirit;
 - Glycol ethers such as methoxy propanol (PM);
 - Glycol ether acetates such as (EGBEA);
 - Ketones such as cyclohexanone;
 - and mixtures thereof.
7. A printing process according to any of Claims 1 to 6, which comprises an adhesion promoters in concentrations up to 50% w/w and are suitably selected among:
 - Acrylic polymers and copolymers emulsions;

- Acrylic polymers and copolymers resins;
- Polyurethane polymers and copolymers emulsions;
- Polyurethane polymers and copolymers resins;
- Aldehyde based resins with polyols (polyether, polyester, urethane and acrylate polyols) and a suitable catalyst;
- Copolymers of vinyl chloride and vinyl acetate with or without functional hydroxyl and/or carboxyl groups;
- Polyvinyl butyrals;
- Aminosilicones;
- and mixtures thereof.

8. A printing process according to any of Claims 1 to 5, wherein the inkjet ink is water based wherein the wetting composition comprises solvents selected among:

- Aliphatic and aromatic hydrocarbons such as petroleum spirit;
- Glycol ether acetates such as (EGBEA);
- Ketones such as cyclohexanone;
- Low alcohols such as ethanol;
- Glycol ethers such as PM;
- and mixtures thereof.

9. A printing process according to Claim 8, which comprises also adhesion promoters selected among:

- Acrylic polymers and copolymers emulsions;
- Acrylic polymers and copolymers resins;
- Polyurethane polymers and copolymers emulsions/dispersions;
- Polyurethane polymers and copolymers resins;
- Aldehyde based resins with polyols (polyether, polyester, urethane and acrylate polyols) and a suitable catalyst;
- Copolymers of vinyl chloride and vinyl acetate with or without functional hydroxyl and/or carboxyl groups;
- Polyvinyl butyrals;

- Aminosilicones;
 - and mixtures thereof.
10. A printing process according to any of Claim 1 to 9, wherein the wetting composition is in amounts ranging from 0.05 cc per 1cm² to 10 cc per cm²,
11. A printing process according to Claim 10, wherein the wetting composition is in amounts ranging from 0.1-0.5 cc per cm².
12. A printing process according to any of Claim 1 to 11, wherein the textile piece is selected among
- 100% cotton
 - 100% Viscose
 - 100% polyester
 - 100% Nylon
 - Blends of the above with or without Lycra/spandex.
13. A printing process according to any of Claim 1 to 12, wherein the textile piece is being wetted on the fly with a wetting composition, immediately thereafter the image is being printed while the piece is still wet; and then the printed textile piece is cured regularly, according to the ink composition.
14. A printing process according to any of Claims 1 to 13, wherein the wetting composition contains adhesion promoters, and another layer is applied over the wet printed image that was printed on the wet textile piece surface.
15. A printing process of a solvent – or of a water-based digital ink directly onto a wet textile piece (as herein defined) that was previously wetted with a wetting composition comprising a high to low volatility solvent or a mixture of such solvents, substantially as hereinbefore defined with reference to the accompanying examples.

For the Applicant
Dr. Yitzhak Hess & Partners

By: 